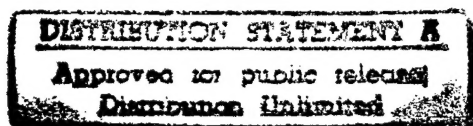


**Basewide Energy
Systems Plan For
Fort McPherson, Georgia**

**Final Report
Executive Summary
Facilities Engineer
Conservation Measures**



Prepared For:

**Savannah District
Corps of Engineers**

DTIC QUALITY INSPECTED 2

Prepared By:

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McLean, VA 22102**

19971021 294

July 1985

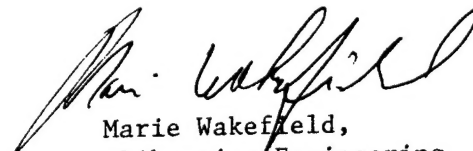


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BASEWIDE ENERGY SYSTEMS PLAN
FOR
FORT McPHERSON, GEORGIA

FINAL REPORT
EXECUTIVE SUMMARY
INCREMENTS A, B, F, AND G

Prepared for:

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Army Contract No. DACA21-80-C-0014
JRB Contract No. 2-815-04-225

July 1985

EXECUTIVE SUMMARY

1. INTRODUCTION

This report presents the results of Increments A, B, F, and G of the Energy Engineering Analysis Program conducted at Fort McPherson, Georgia, by JRB Associates under Contract No. DACA21-80-C-0014. This report includes analyses of the energy patterns at the facility, and the identification and evaluation of energy conservation opportunities. The results obtained indicate that energy use at Fort McPherson has decreased almost 15 percent from FY 1975 figures. These reports are organized into 4 volumes, plus appendices.

2. EXISTING ENERGY USE

Electricity, natural gas, and fuel oil are the main energy sources at Fort McPherson. In FY 1975 the total energy use at the Post was 446,600 MBtu. A summary of the FY 1984 basewide energy use by fuel type is given in Table 1, which shows that electricity currently accounts for approximately 65.0 percent of total energy use. Total energy use at the Post for the years 1977 to 1984 is shown in Table 2.

Early work in this study emphasized energy use in buildings. Initial data for the study were gathered through a series of site visits during which buildings were inventoried, patterns of building energy use were identified, and typical buildings were selected for detailed study in each category. Energy use data was analyzed to determine how much energy the various types of buildings use and their functional energy use. Since this effort took place in 1980, FY 1979 energy use data was the basis of the analysis. Figures 1, 2, 3, and 4 provide a summary of the building inventory and energy use in FY 1979. The energy profiles in these figures were developed by evaluating the energy use of typical buildings and expanding those values to represent the entire Post.

3. ENERGY CONSERVATION MEASURES DEVELOPED

The energy conservation opportunities at Fort McPherson are summarized in Table 3. This table shows all projects evaluated and the resulting economic

TABLE 1. ENERGY USE AT FORT McPHERSON - FY 1984

<u>ENERGY SOURCE</u>	<u>PURCHASED ENERGY</u>	<u>SOURCE USE</u>
Electricity	21,259,200 kWh	246,607 MBtu
No. 2 Fuel Oil	32,478 gallons	4,505 MBtu
Natural Gas	1,284,978 therms	128,498 MBtu
Total		379,610 MBtu

TABLE 2. ANNUAL ENERGY USE AT FORT McPHERSON - FY 1977 - 1984 (MBtu)*

ENERGY SOURCE	FY 1977	FY 1978	FY 1979	FY 1980	FY 1981	FY 1982	FY 1983	FY 1984
Electricity	231,600	216,500	206,963	214,870	223,388	240,816	251,395	246,607
Natural Gas	175,500	164,400	155,500	153,729	148,740	146,607	137,600	128,498
No. 2 Fuel Oil	38,300	23,800	6,400	--	--	7,077	1,191	4,505
TOTAL	445,400	404,700	368,863	368,599	372,128	394,500	390,186	379,610

SOURCE: Fort McPherson Facilities Engineer

*Source energy uses for 1975 was not available. Total use was 446,600.

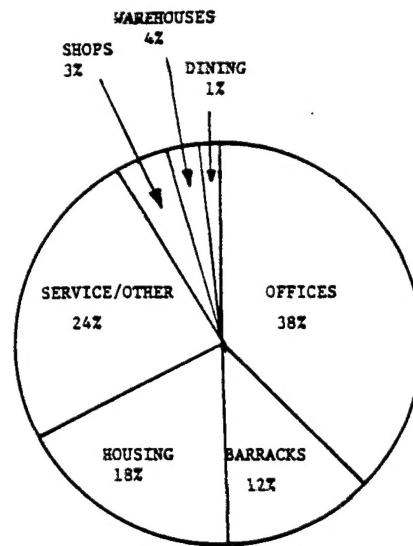


FIGURE 1. BUILDING AREA PROFILE BY CATEGORY (FY 1979)

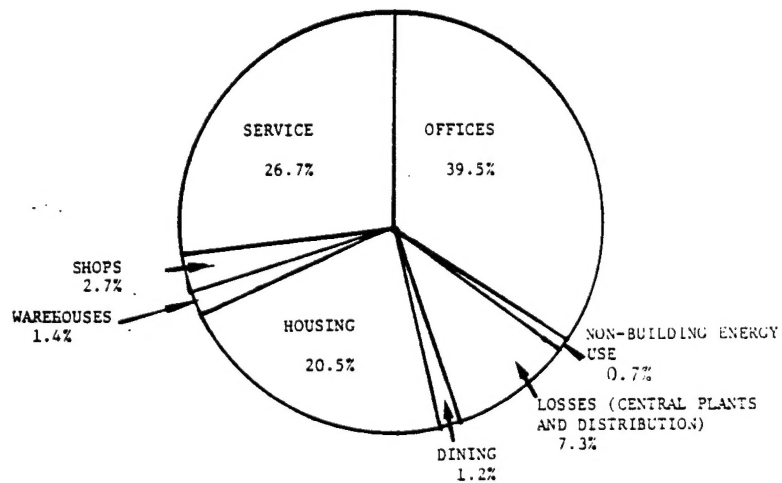


FIGURE 2. ENERGY USE BY BUILDING CATEGORY (FY 1979)

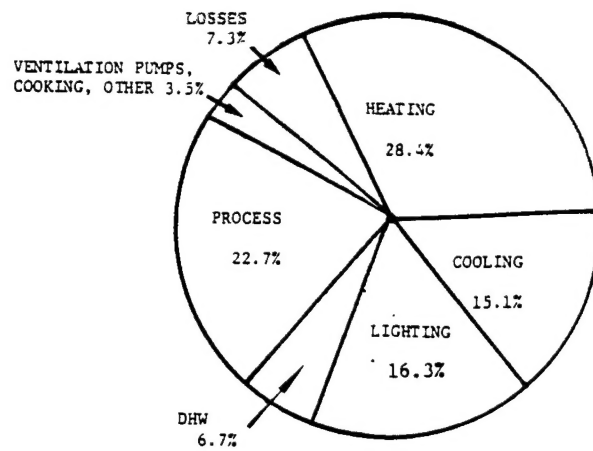


FIGURE 3. ENERGY USE BY BUILDING SYSTEM (FY 1979)

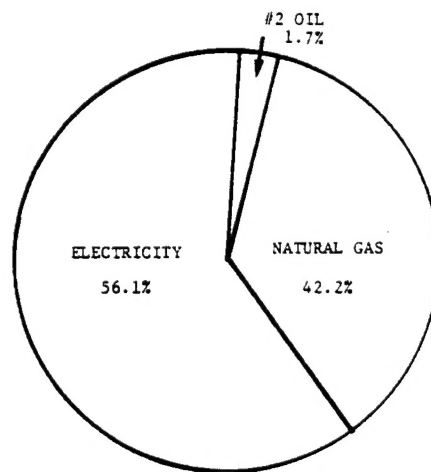


FIGURE 4. ACTUAL ENERGY USE (FY 1979)

TABLE 3. EVALUATED PROJECTS - FORT McPHERSON

PROJECT DESCRIPTION	ECONOMICS INDICES			ENERGY SAVINGS (MBTU/YR)				CWE (\$)	Annual Savings (\$)
	E/C	B/C	Payback (yrs.)	Category	Fuel Oil	Nat. Gas	Elec.		
Building Shell									
Reduce Window Openings	5.4	0.5	--	X					
Storm Windows*	--	2.2	10.4	ECIP #2		5,084	--	302,270	28,978
Wall Insulation	--	1.7	13.6	X		5.70	--	44,141	3,249
Ceiling Insulation*	18.8	2.2	8.35	ECIP #3		9,610.0	--	511,097.09	61,215.70
Loading Dock Door Seals	No Applications								
Reduce Solar Heat Gain	<3	<0.5		X					
Vestibules	1.0	0.2		X					
Storm Doors	8.2	0.9		X					
Reduce Door Size	No Applications								
Replace Doors	1.2	0.8		X					
Reduce Infiltration in Family Housing	--	1.7	16.5	OSM		551	551	31,516	1,912
Enclosure Loading Dock (Curtains) (Strips)	No Applications No Applications								

X Does not meet economic criteria

* Also in Family Housing ECIP

TABLE 3. EVALUATED PROJECTS - FORT MCPHERSON (Continued)

PROJECT DESCRIPTION	ECONOMICS INDICES			ENERGY SAVINGS (MBTU/YR)				CWF (\$)	Annual Savings (\$)
	E/C	B/C	Payback (yrs.)	Category	Fuel Oil	Nat. Gas	Elec.		
<u>Lighting</u>									
Replace Incandescent Lighting: Bldg. 500	68.3	6.8	2.69	ECIP #6	--	--	678.11	9,927.00	3,689
Replace Incandescent Lighting: Misc. Bldgs.	74	6.6	1.8	O&M	--	--	3,981.91	53,723	29,065
Replace Incandescent Lighting: Bldg. 363	20.0	2.2	9.19	ECIP #6	--	--	390.05	19,500.00	2,122
Reduce Height of Luminaires	No Applications								
Add Switching	No Applications								
Add controls to Shut Lamps Off	No Applications								
Use Automatic Dimming Controls	2.8	.3	67.17	X					
Site Lighting	33.1	3.6	5.51	ECIP #6	--	--	1,007.7	30,482.00	5,482
Exit Lighting	--	7.1	1.7	QRIP			848	8,235	4,971

X Does not meet economic criteria

TABLE 3. EVALUATED PROJECTS - FORT MCPHERSON (Continued)

PROJECT DESCRIPTION	ECONOMICS INDICES			ENERGY SAVINGS (MBTU/YR)				CWE (\$)	Annual Savings (\$)
	E/C	B/C	Payback (yrs.)	Category	Fuel Oil	Nat. Gas	Elec.		
<u>Building Heating & Cooling</u>									
Eliminate Unnecessary Roof Vents	No Applications								
Recirculate Exhaust Air Through Charcoal	6.9	.6		X					
Reduce Air Flow Rates	109.6	7.7	1.56	ECIP #6		354.56	476.56	831.12	4,581
Shut Down Ventilation Systems	No Applications								
Heat Wheels for Recovery	No Applications								
Temperature Setback* (Offices)	(See ECIP #5, EMCS)								
Warm-Up Cycle Controls	2.8	.3		X					
Automatic Control Valves for Radiators	No Applications								
Rezone Heating System	No Applications								
Replace Gas Pilots with Spark Ignition*	35.3	2.6	4.88	ECIP #6	--	994.80	--	994.80	5,771
Recover Heat (Laundry)	10.4	1.3	15.07	ECIP #6	--	550		550	
Economizer Controls	2.5	.2		X					
									3,504

X Does not meet ECIP economic criteria

* Also in Family Housing ECIP

TABLE 3. EVALUATED PROJECTS - FORT McPHERSON (Continued)

PROJECT DESCRIPTION	ECONOMICS INDICES			ENERGY SAVINGS (MBTU/YR)				CWE (\$)	Annual Savings (\$)
	E/C	B/C	Payback (yrs.)	Category	Fuel Oil	Nat. Gas	Elec.		
Building Heating & Cooling (continued)									
Control Hot & Cold Deck	No Applications								
VAV Systems	No Applications								
Shut Down Air Conditioning Systems	No Applications								
Spot Cooling	No Applications								
Deadband Thermostats	No Applications								
Outside Air Reset Controls	No Applications								
Attic Ventilation	No Applications								
Heat Pumps	1.4	.1		X					
Air Stratification	--	7.6	3.1	OGM	22	98	(-19)	101	617
Domestic Hot Water									
Reduce DHW Temperatures	--	345	0.1	OGM		1,155		1,155	6,584
Use Local Hot Water Heaters	No Applications								431
Use Solar Heating	10.1	.8	--	X					
Install Flow Restrictors	--	38	0.6	QRIP		1,760		1,760	5,983
									101,032

X Does not meet economic criteria

TABLE 3. EVALUATED PROJECTS - FORT MCPHERSON (Continued)

PROJECT DESCRIPTION	ECONOMICS INDICES		ENERGY SAVINGS (MBTU/YR)				CWE (\$)	Annual Savings (\$)	
	E/C	B/C	Payback (yrs.)	Category	Fuel Oil	Nat. Gas			Elec.
<u>Domestic Hot Water (continued)</u>									
Desuperheaters									
o Barracks	40.5	4.47	4.2	ECIP #6	--	355.17	--	8,770	2,090
o Food Service	15.3	1.6	14.37	ECIP #6	--	263.5	--	17,254	1,201
Insulate Hot Water Tanks:									
o Family Housing	5.9	.7	26.50	X					
o Other Buildings	5.6	.7	28.55	X					
<u>Miscellaneous</u>									
Use Variable Speed Pumps	No Applications								
Motor Generator Sets	No Applications								
High-Efficiency Motors		1.8	5.1	O&M		20		233	45
<u>Family Housing</u>	19.1	2.0	8.2	ECIP #4	--	7,617.74	--	398,222	48,455
o Ceiling Insulation									
o Storm Windows									
o Night Setback									
o Thermostats									
o Spark Ignition									
o Flue Gas Dampers									

X Does not meet economic criteria

TABLE 3. EVALUATED PROJECTS - FORT MCPHERSON (Continued)

PROJECT DESCRIPTION	ECONOMICS INDICES			ENERGY SAVINGS (MBTU/YR)			CWE (\$)	Annual Savings (\$)
	E/C	B/C	Payback (yrs.)	Category	Fuel Oil	Nat. Gas		
<u>Central Heating/Cooling Plants</u>								
Flue Gas Analyzer	9.2	0.9	25	X				
Boiler Economizer	N/A							
Boiler Water Treatment	N/A							
Variable Speed Chiller Motor	N/A							
Reset Chilled Water Chiller Economizer	N/A							
Return Condensate	N/A							
Insulate Pipes (See O&M, Section 4-6)	N/A							
Add Flue Dampers	N/A							
Automatic Condenser Cleaning	1.2	.02	160	X				
Refuse Derived Fuels	N/A*							
EMCS	27.4	1.8	6.35	ECIP	607.7	4,043.2	4,650.9	26,714

*Option evaluated only for conversion of existing boilers and not the installation of a central refuse burning facility.

indices. These energy conservation opportunities were developed by analyzing their applicability to typical buildings. Those that met ECIP criteria were developed into projects with appropriate documentation (DD Forms 1391 and PDB). Table 4 provides a listing of all the recommended projects including other projects identified in Increment F & G.

4. ENERGY AND COST SAVINGS

The total energy savings potential of the recommended energy conservation projects is 41,096 MBtu per year. This represents an estimated energy cost savings of \$244,813.

5. RESULTS OF INCREMENT A - BUILDINGS

The scope of Increment A included an engineering analysis of all existing buildings and processes at Fort McPherson. For each type of building, specific characteristics having a significant effect on energy use were identified. Table 5 shows these characteristics. The energy use of these buildings is identified in that table. Based upon these analyses, energy conservation projects were evaluated using ECIP criteria to determine acceptability. The recommended ECIP projects developed under Increment A are identified in Table 4.

6. RESULTS OF INCREMENT B - DISTRIBUTION SYSTEMS, EMCS

The scope of Increment B involved an engineering analysis of the Post's utilities, energy distribution systems, conversion of existing plants, and the potential for an EMCS. Load profiles for each energy source were performed. The annual energy use profile for fossil fuel and electricity are presented in Figures 5, 6, 7, and 8. Table 6 summarizes the energy conservation projects evaluated under Increment B. Of the projects evaluated, only the expansion of the EMCS initially met ECIP criteria. This evaluation provided for the expansion of the existing IBM FC/PM 2 system by increasing the existing 75 control points to 256. The subsequent evaluation of a new central system to provide for the additional points proved to be uneconomical. Hence, no projects in Increment B met ECIP criteria.

TABLE 4. ENERGY CONSERVATION OPPORTUNITIES - FORT MCPHERSON

INCRE- MENT	PROJECT DESCRIPTION	E/C	SIR OR B/C*	PAYBACK (Yrs)	FUNDING CATEGORY	FUEL OIL (MBtu)	NAT. GAS (MBtu)	ELFC. (MBtu)	TOTAL (MBtu)	CWE (\$)	ANNUAL SAVINGS (\$)
F	Reduce Domestic Hot Water Temperatures	--	345	0.1	O&M	--	1,155	--	1,155	431	6,584
F	Install Flow Restrictors	--	38	0.6	QRIP	--	1,760	--	1,760	5,983	10,032
F	Reduce Infiltration Miscellaneous Buildings on Post	--	12.8	1.8	QRIP	--	5,035	--	5,035	48,334	26,443
F	High Efficiency Fluorescents (each) 1	--	8.2	1.1	O&M	--	--	0.5	0.5	1.20	1.09
F	Reduce Stratification Heat Losses in High- Bay Areas	--	7.6	3.1	O&M	22	98	-19	101	1,910	617
F	Install Fluorescent Lamps in Exit Lights	--	7.1	1.7	QRIP	--	--	848	848	8,235	4,971
G	Replace Incandescent Lamps with Fluorescent Lamps	74	6.6	1.8	O&M	--	--	3,982	3,982	53,723	29,065
F	Electronic Ballasts (each) 2	--	4.8	1.8	O&M	--	--	2.1	2.1	12.00	7.00
A	Energy Conservation Improvements for Various Buildings	34.5	2.0	6.0	ECIP	--	2,502	2,280	4,782	138,679	23,290
A	Ceiling Insulation	18.8	2.3*	8.4	ECIP	9,610	--	--	9,610	511,097	61,216
A	Storm Windows	--	2.2	10.4	ECIP	--	5,084	--	5,084	302,270	28,979
A	Energy Conservation Improvements for Family Housing: o Roof Insulation o Storm Windows o Night Setback Thermostats o Spark Ignitors o Flue Gas Dampers	19.1	2.0	8.2	ECIP	7,618	--	--	7,618	398,221	48,455

TABLE 4. ENERGY CONSERVATION OPPORTUNITIES - FORT McPHERSON (Continued)

INCREMENT	PROJECT DESCRIPTION	E/C	SIR OR B/C*	PAYBACK (Yrs)	FUNDING CATEGORY	FUEL OIL (MBtu)	NAT. GAS (MBtu)	ELEC. (MBtu)	TOTAL (MBtu)	CWE (\$)	ANNUAL SAVINGS (\$)
F	High-Efficiency Motor (each)	--	1.8	5.1	O&M	--	--	20	20	233	45
F	Reduce Infiltration in Family Housing	--	1.7	16.5	O&M	--	551	--	551	31,516	1,912
A	Wall Insulation	--	1.7	13.6	O&M	--	570	--	570	44,141	3,249
TOTALS						17,250	16,755	7,091	41,096	1,544,540	244,813

1 168 hours/week operation, replace at failure - not included in table totals.
2 Two 40w bulb fixtures at 168 hours/week use, replace at failure - not included in table totals.
3 25 hp motor, replace at failure, 550 hours/week operation - not included in table totals.

TABLE 5. FORT McPHERSON CATEGORY DIVISIONS - TYPICAL BUILDINGS

CATEGORY	SUBGROUP	TYPICAL BUILDING	HEATED SQ. FT.	COOLED SQ. FT.	WALL TYPE	ROOF TYPE
A OFFICE						
	A-1	65	132453	132455	Brick	Wood
	A-2	112	30564	26333	Tile	Wood
	A-3	131	136511	136511	Brick	Wood
	A-4	206	62598	62958	Block	Wood
	A-5	275	211161	207085	Wood	Wood
	A-6	210	71996	71996	Block	Wood
	TOTAL		645285	636978		
B DINING						
	B-1	61	14230	14230	Brick	Wood
	TOTAL		14230	14230		
C HOUSING						
	C-1	14	143992	32211	Brick	Wood
	C-2	58	132580	93573	Brick	Wood
	C-3	139	6979	0	Brick	Wood
	C-4	410	28980	0	Brick	Wood
	C-5	527	121496	0	Brick	Wood
	C-6	275*	59607	55253	Wood	Wood
	C-7	112*	7452	7452	Tile	Wood
	TOTAL		501086	188489		

* Typical for building shell only; not included in category.

TABLE 5. FORT McPHERSON CATEGORY DIVISIONS DIVISIONS - TYPICAL BUILDINGS
(continued)

CATEGORY	SUBGROUP	TYPICAL BUILDING	HEATED SQ.FT.	COOLED SQ.FT.	WALL TYPE	ROOF TYPE
D WAREHOUSES	D-1	218	50338	24465	Wood	Wood
	D-2	14*	2361	0	Brick	Wood
	D-3	112*	1643	0	Tile	Wood
	D-4	362	14181	0	Brick	Metal
	TOTAL		68523	24465		
E SHOPS	E-1	65*	7552	7552	Brick	Wood
	E-2	131	8882	8876	Brick	Wood
	E-3	345	9173	0	Metal	Metal
	E-4	356	9076	7666	Tile	Wood
	E-5	362*	11986	4475	Block	Metal
	E-6	218*	2238	0	Wood	Wood
	TOTAL		48907	28567		
F SERVICE/OTHER	F-1	65*	44027	43991	Brick	Wood
	F-2	218*	8603	0	Wood	Wood
	F-3	275*	43593	29702	Wood	Wood
	F-4	401	18337	18337	Block	Wood
	F-5	362*	4162	0	Brick	Metal
	F-6	362*	4426	0	Brick	Metal
	F-7	360	32609	32609	Brick	Metal
	F-8	209	10074	0	Block	Wood
	F-9	363	174290	85000	Other	Conc.
	F-10	500	22917	22642	Other	Wood
	F-11	112*	22198	13710	Tile	Wood
	F-12	131*	22832	22832	Brick	Wood
	TOTAL		408068	268823		

* Typical for building shell only. Not in category.

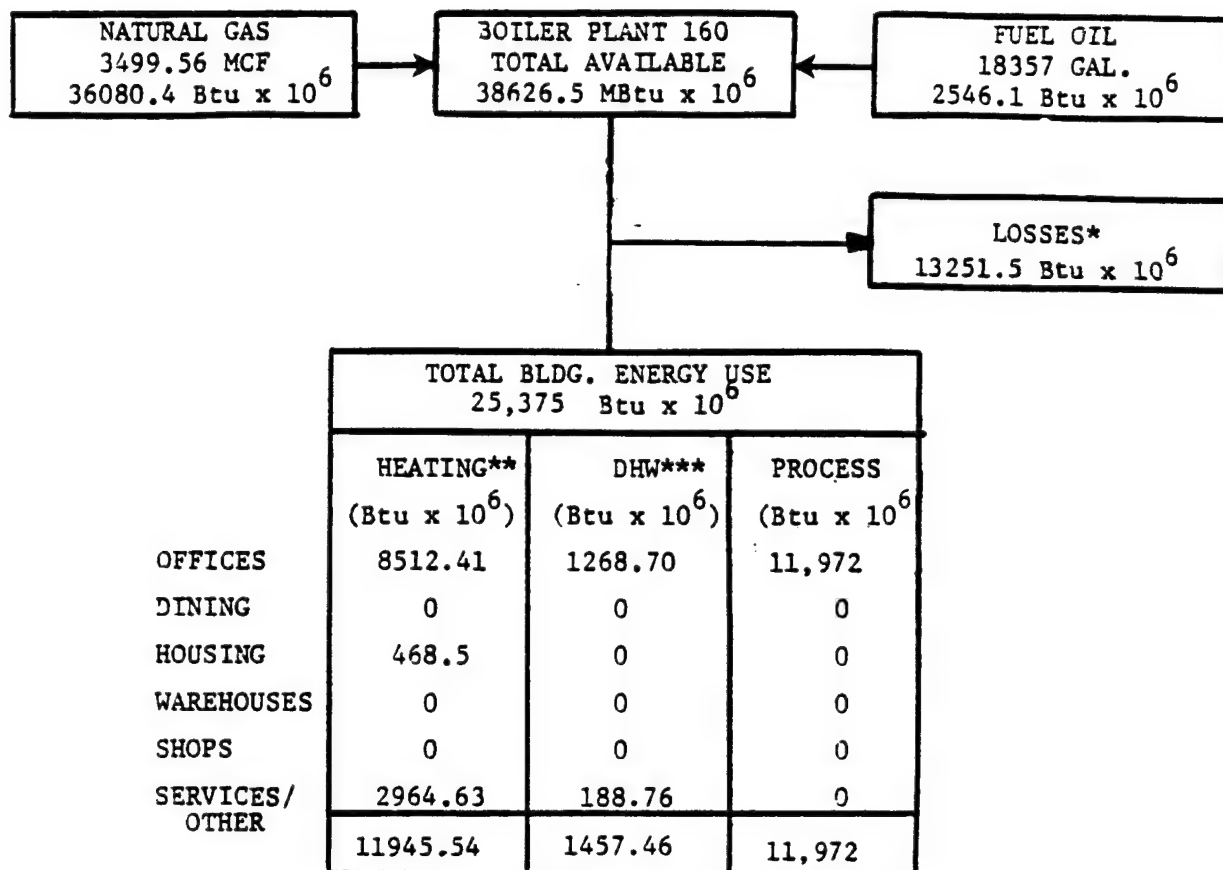


FIGURE 5. FUEL OIL, NATURAL GAS USE - BOILER PLANT 160

*Value from Appendix H, Increment A Report

**Value from Appendix D, Increment A Report

***Value from Appendix D, Increment A Report

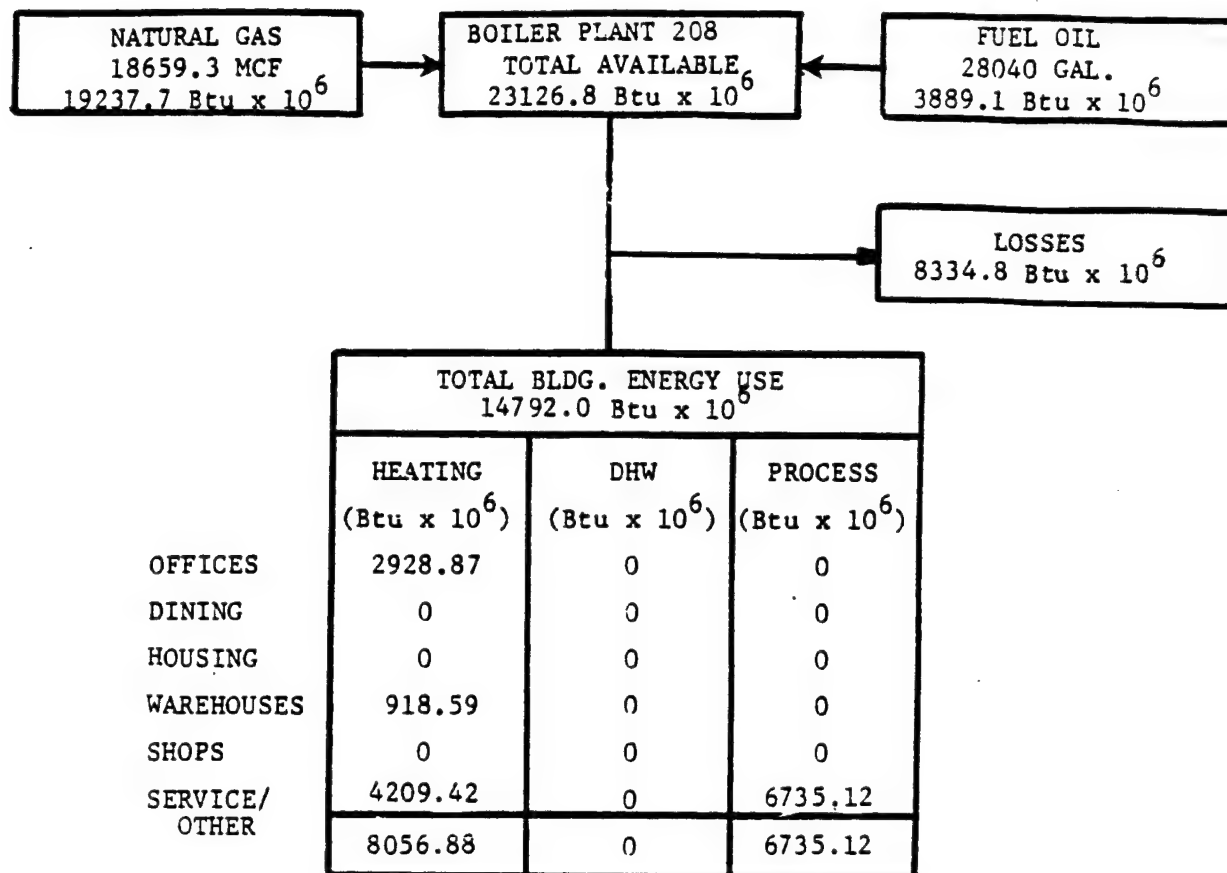


FIGURE 6. FUEL OIL, NATURAL GAS USE - BOILER PLANT 208

* Value from Appendix H, Increment A Report

** Value from Appendix D, Increment A Report

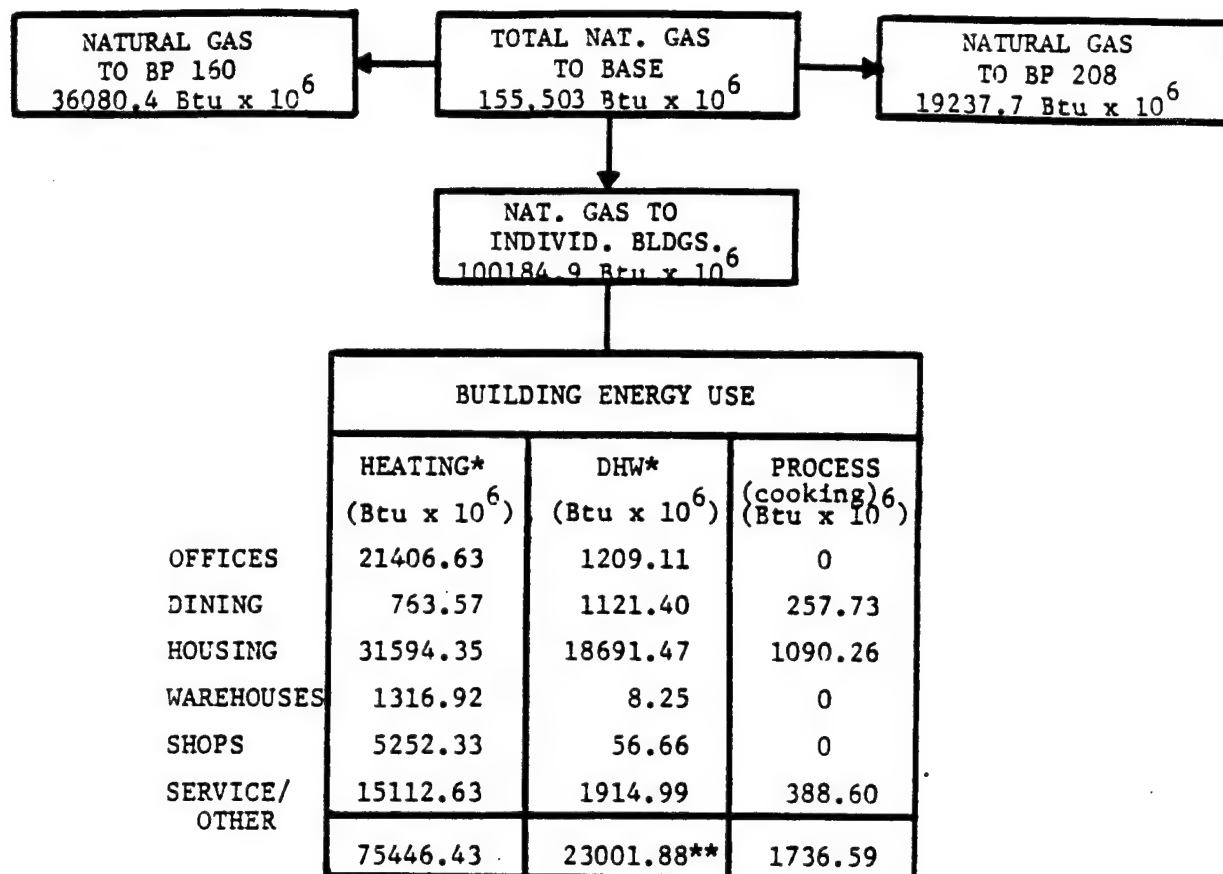


FIGURE 7. NATURAL GAS USE

*Includes losses based on $\eta = .75$

**Values shown on page D-15 of Appendix D.

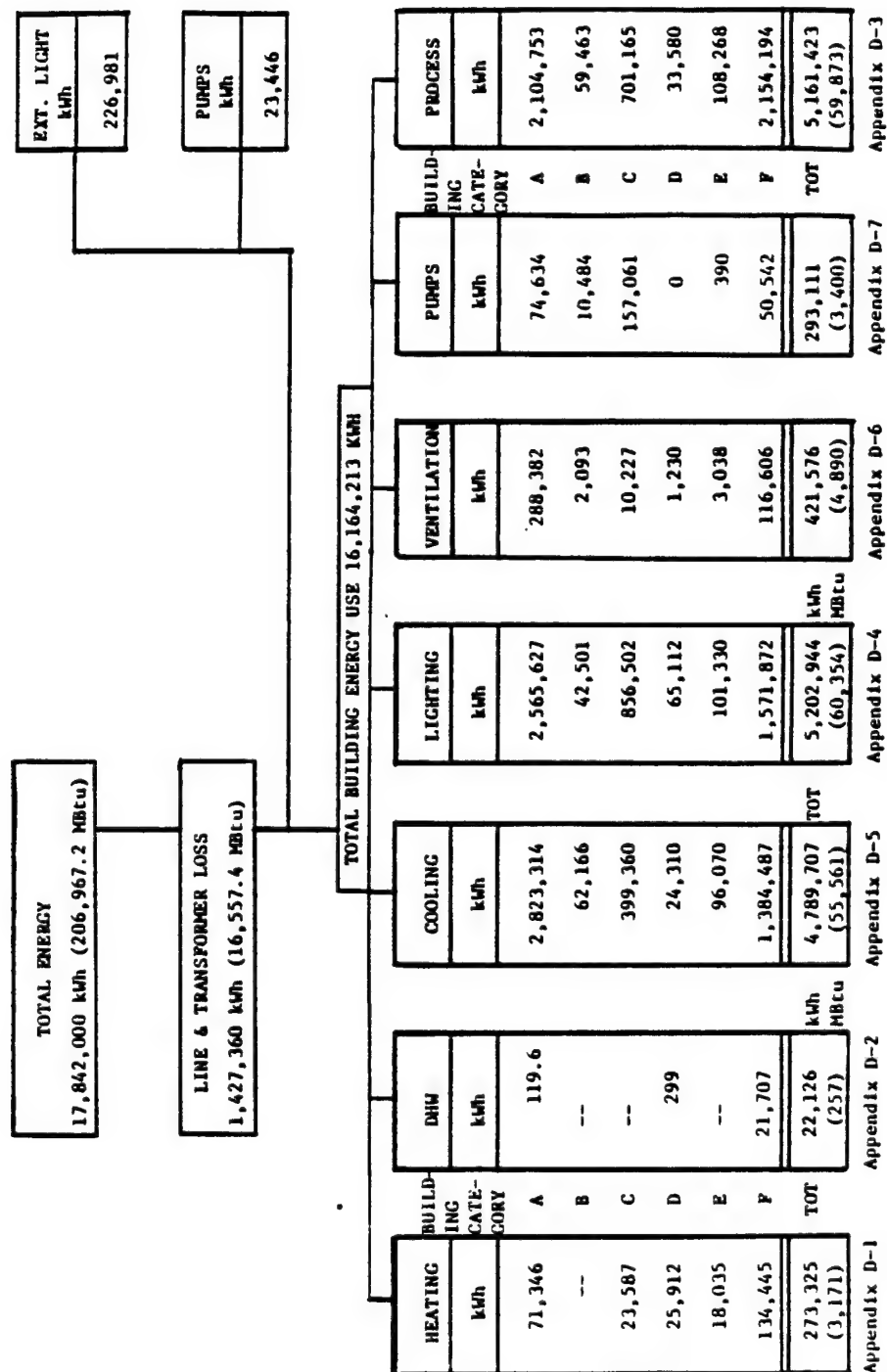


FIGURE 8. ANNUAL BASEWIDE ELECTRICITY USE

Values in parentheses are MBtu.

TABLE 6. ENERGY CONSERVATION OPPORTUNITIES EVALUATED UNDER INCREMENT B

CENTRAL HEATING/COOLING PLANTS	ACTION TAKEN
Flue Gas Analyzer	NR
Boiler Economizer	NR
Boiler Water Treatment	NR
Variable Speed Chiller Motor	NR
Reset Chilled Water Chiller Economizer	NR
Return Condensate	NR
Insulate Pipes	NR
Add Flue Dampers	NR
Automatic Condenser Cleaning	NR
Refuse Derived Fuels	NR
EMCS	ECIP prepared

NR = Not Recommended

7. RESULTS OF INCREMENT F - FACILITY ENGINEER CONSERVATION MEASURES

The scope of work under Increment F is the identification of energy conservation opportunities that are within the Facilities Engineer funding authority, or which satisfy QRIP, OSD PIF, or PECIP requirements. In the performance of the Increment F evaluation, 18 buildings on Post were evaluated and 13 infiltration tests were performed.

Another element of the Increment F report is to identify the energy conservation measures accomplished by the Post since 1975. Installation initiated actions to conserve energy use at Fort McPherson include the following:

- Time clocks installed for controlling building heating and cooling systems;
- Manual shutdown of building systems during unoccupied periods;
- EMCS installation; and
- Family housing insulation.

These efforts have resulted in a decrease in energy use of almost 15 percent over FY 1975 energy use. The recommended Increment F projects are presented in Table 7.

During the course of the Increment F studies, four ECIP's were re-evaluated. These new values are shown in Table 4.

8. RESULTS OF INCREMENT G - MINOR CONSTRUCTION PROJECTS AND CHANGES IN OPERATION AND MAINTENANCE

The scope of work for Increment G was to identify cost-effective energy saving projects which do not qualify for ECIP funding. Increment G work was performed in conjunction with Increments A and B. The recommended projects are listed in Table 5.

9. ENERGY PLAN

The impact of JRB-recommended energy conservation projects and future Post actions on annual energy use results in a projected annual energy use of

TABLE 7. RECOMMENDED ENERGY CONSERVATION OPPORTUNITIES
AT FORT McPHERSON - INCREMENT F

ENERGY OPTION	FUNDING	COST (\$)	ENERGY SAVINGS (MBTtu)	ANNUAL COST SAVINGS (\$)	SIR	SIMPLE PAYBACK (YEARS)
Reduce Domestic Hot Water Temperatures	O&M	431	1,155	6,584	345	.07
Install Flow Restrictors	QRIP	5,983	1,760	10,032	38	.6
Reduce Infiltration Miscellaneous Buildings	QRIP	48,334	5,035	26,443	12.8	1.8
High Efficiency Fluorescents (each) ¹	O&M	1.20	0.50	1.09	8.2	1.1
Reduce Stratification Heat Losses in High-Bay Areas (Bldg. 363)	O&M	1,910	101	617	7.6	3.1
Install Fluorescent Lamps in Exit Lights Basewide	QRIP	8,235	848	4,971	7.1	1.7
Electronic Ballasts (each) ²	O&M	12	2.1	7	4.8	1.8
High Efficiency Motors (each) ³	O&M	233	20	45	1.8	5.1
Reduce Infiltration in Family Housing	O&M	31,516	551	1,912	1.7	16.5
TOTALS		96,409	9,450	50,559		

¹168 hours/week operation, replace at failure - not included in table totals.

²Two 40w bulb fixture at 168 hours/week use, replace at failure - not included in table totals.

³Value for 25 hp motor replacement at failure, 50 hours/week use - not included in table totals.

338,814 MBtu's. The estimated annual energy use decrease comparing FY 1975 values to FY 1985 is 15 percent. Table 8 shows FY 1985 projected energy use.

A comparison of annual energy use per square foot of Fort McPherson floor area is shown in Table 9. The projected percent change from FY 1975 to FY 1985 is a three percent increase.

10. RESULTS AND RECOMMENDATIONS

The quantity of energy use at Fort McPherson should continue to decrease with continued emphasis on energy conservation and with the new headquarters building replacing a number of temporary buildings. Additional recommendations for energy use reduction are:

- Maintain the current energy conservation program at the Post level;
and
- Continue to program and fund major energy conservation projects.

TABLE 8. FORECAST ENERGY USE BY FUEL TYPE (1985)

FUEL TYPE	1984 ENERGY USE (MBtu)	ENERGY REQUIRED BY NEW CONSTRUCTION	DEMOLITION	1985 FORECAST (MBtu)
Electricity	246,607	783	(389)	247,001
#2 Fuel Oil	4,505	0	(40)	4,465
Natural Gas	128,498	284	(338)	128,445
Total	379,610	1,067	(767)	379,910

TABLE 9. ENERGY USE, ACTUAL AND PROJECTED WITH
PERCENTAGE OF INCREASE

FY	1975	1982	1983	1984	% INCREASE FROM 1975 (OVER 1983)	PROJECTED USE 1985	% INCREASE FROM 1975
Energy Use 10^6 Btu/yr	446,600	394,500	390,187	379,610	(-15.0)	379,910	(-14.9)
Square Feet ($\times 10^3$)	1,518	--	--	1,261	(-16.9)	1,250	(-17.7)
Energy (10^6) Use per Sq. Ft.	0.294	--	--	0.301	2.4	0.304	3.4